CHAPTER 3

BREAKWATER AND JETTY PLANS

3-1. Objective. The layout of a breakwater or a jetty will depend on the intended function of the structure. A breakwater used to protect a small-boat harbor must reduce wave heights to an acceptable level in the interior channels and moorage area whereas a jetty used to stabilize an ocean inlet must reduce or eliminate channel shoaling. The goal of jetty placement is to direct tidal currents to keep the channel scoured to a suitable depth, much the same as the function of a river training dike.

3-2. Layout Options. Many options are available for breakwater and jetty layouts. The option selected must ensure that the structure functions as desired, is cost effective, and meets socio-economic constraints. Major layout options are presented below.

a. Attached or Detached. Jetties are usually attached to dry land in order to perform their function of stabilizing an inlet or eliminating channel shoaling. Breakwaters may be able to most economically serve their purpose either as attached or detached structures. If the harbor to be protected is on the open coastline and the predominant wave direction is such that wave crests approach parallel to the coastline, a detached offshore breakwater might be the best option. An attached breakwater extended from a natural headland could be used to protect a harbor located in a cove. As shown in figure 3-1 a system of attached and detached breakwaters may be used. An advantage of attached breakwaters is ease of access for construction, operation, and maintenance; however, one disadvantage may be a negative impact on water quality due to effects on natural circulation.

b. Overtopped or Nonovertopped. Overtopped structures are built to a crown elevation which allows larger waves to wash across the crest; therefore, wave heights on the protected side are larger than for a nonovertopped structure. Nonovertopped structures are constructed to an elevation that precludes any significant amount of wave energy from coming across the crest. Nonovertopped breakwater or jetty sections provide a greater degree of wave protection than overtopped structures, but they are more costly to build because of the increased volume of materials required. Selection of crest elevation, and thus amount of wave overtopping expected, can be optimized in a hydraulic model investigation by determining the magnitude of transmitted wave heights associated with various crest elevations, with the optimum crest elevation usually being the minimum structure height that provides the needed degree of wave protection. The crest elevation of an overtopped breakwater can sometimes be set by the design wave height that can be expected during the period the harbor will be used. This is especially true in colder climates. Overtopped structures are more difficult to design because their stability response is strongly affected by small changes in the still water level (swl).

c. Submerged. There may be instances where the needed degree of wave

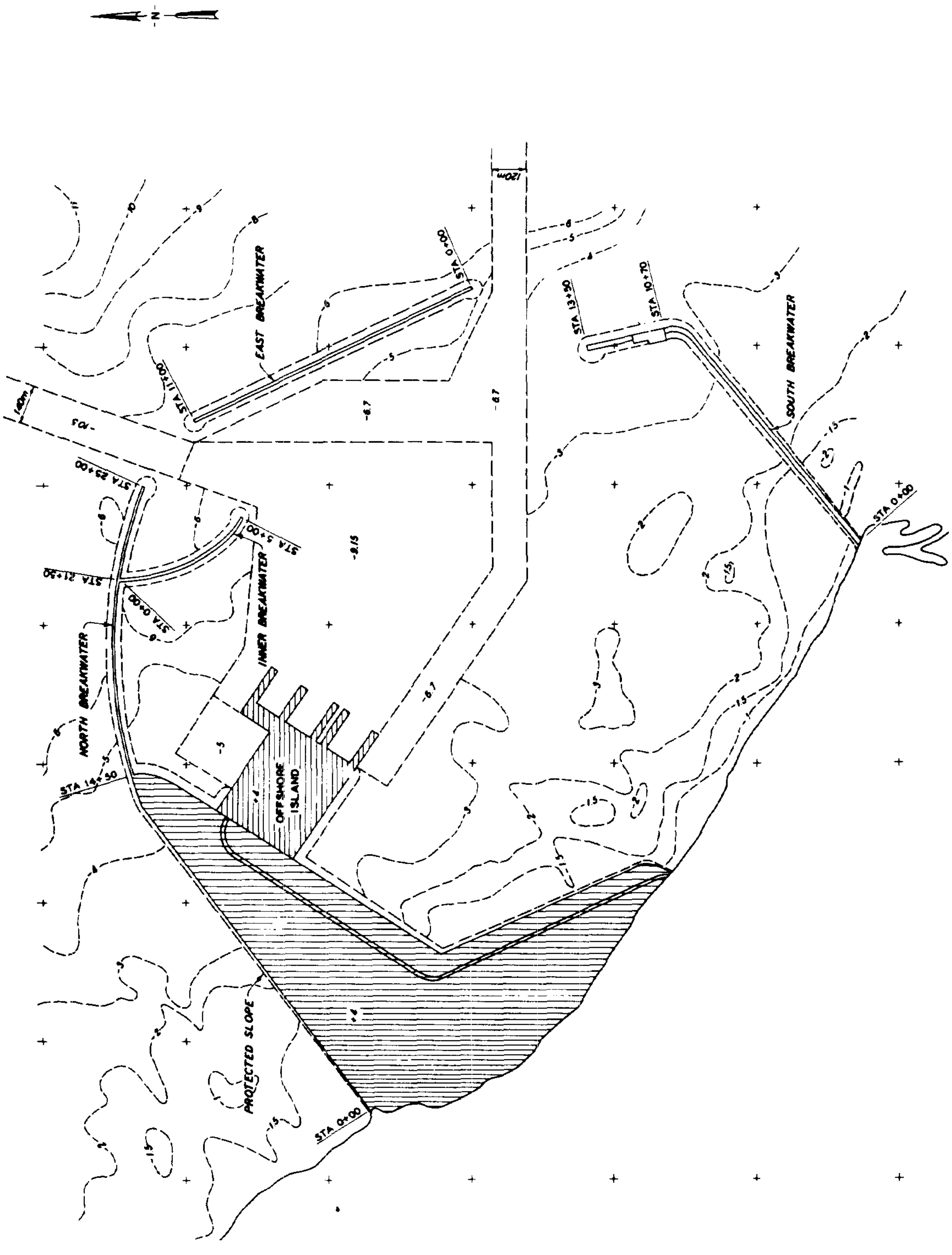

Figure 3-1. System of attached and detached breakwaters

protection can be achieved with submerged structures such as a detached breakwater constructed parallel to the coastline and designed to dissipate sufficient wave energy to eliminate or reduce shoreline erosion. Submerged breakwaters are less expensive to build than high-crested types and may be aesthetically more pleasing since they do not encroach on any scenic view which may be present. Some disadvantages, compared with a typical high-crested breakwater, are that significantly less wave protection is provided, monitoring the structure's condition is more difficult, and navigation hazards may be created.

d. Single or Double. Since the goal of jetty placement is to direct tidal currents to keep the channel scoured to a suitable depth, double parallel jetties will normally be required. However, there may be instances where coastline geometry is such that a single updrift jetty will provide a significant amount of stabilization. One disadvantage of single jetties is the tendency of the channel to migrate toward the structure. Choice of single or double breakwaters will depend on such factors as coastline geometry and predominant wave direction. Typically, a harbor positioned in a cove will be protected by double breakwaters extended seaward and arced toward each other with a navigation opening between the breakwater heads. For a harbor constructed on the open coastline a single offshore breakwater with appropriate navigation openings might be the more advantageous.

e. Weir Section. Some jetties are constructed with low shoreward ends that act as weirs. Water and sediment can be transported over this portion of the structure for part or all of a normal tidal cycle. The weir section, generally less than 500 feet long, acts as a breakwater and provides a semi-protected area for dredging of the deposition basin when it has filled. The basin is dredged to store some estimated quantity of sand moving into the basin during a given time period. A hydraulic dredge working in the semi-protected waters can bypass sand to the downdrift beach. Additional information on weir sections can be obtained from item 140. Figure 3-2 shows a typical weir section in a jetty system.

f. Deflector Vanes. In many instances where jetties are used to help maintain a navigation channel, currents will tend to propagate along the oceanside of the jetty and deposit their sediment load in the mouth of the channel. As shown in figure 3-3, deflector vanes can be incorporated into the jetty design to aid in turning the currents and thus help to keep the sediments away from the mouth of the channel. Position, length, and orientation of the vanes can be optimized in a model investigation. It should be noted that at the time this manual was prepared, the deflector vanes shown in figure 3-3 had been model tested but had not been used in the prototype.

g. Arrowhead Breakwaters. When a breakwater is constructed parallel to the coastline, as shown in figure 3-4, navigation conditions at the navigation opening may be enhanced by the addition of arrowhead breakwaters. Prototype experience with such structures however has shown them to be of questionable benefit in some cases.

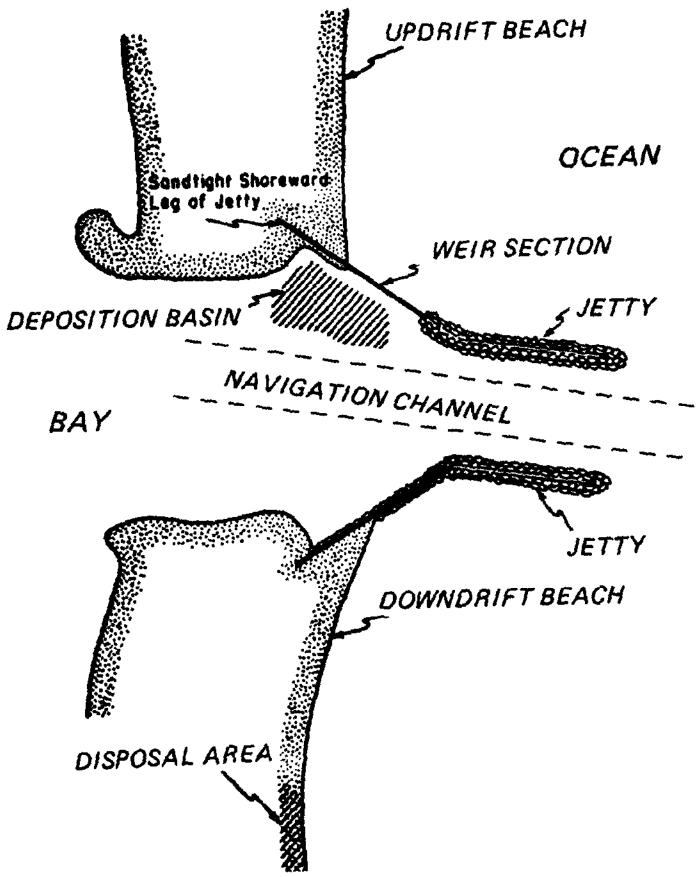

Figure 3-2. Key elements of a typical weir section in a jetty system

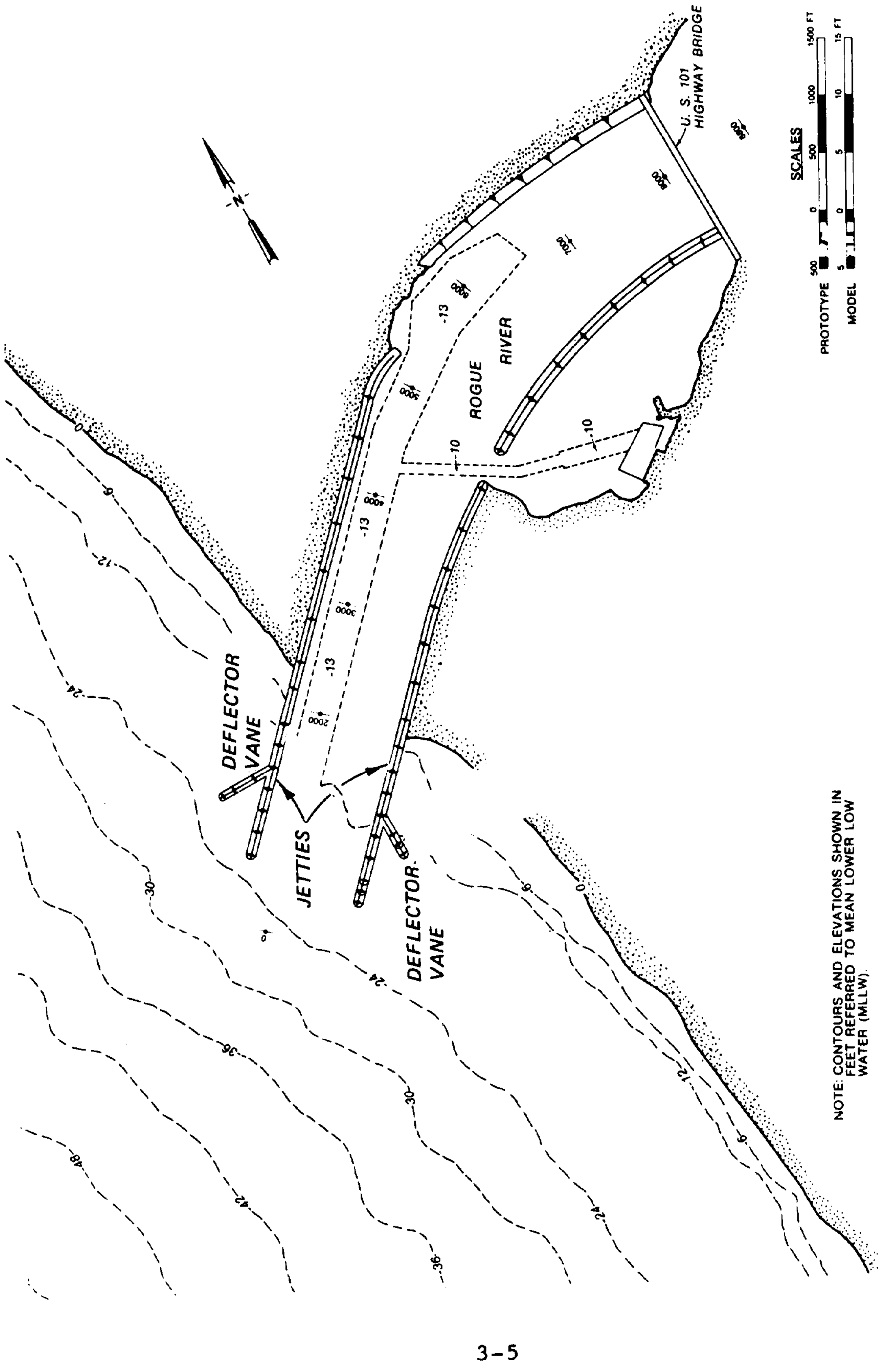

Figure 3-3. Typical use of deflector vanes

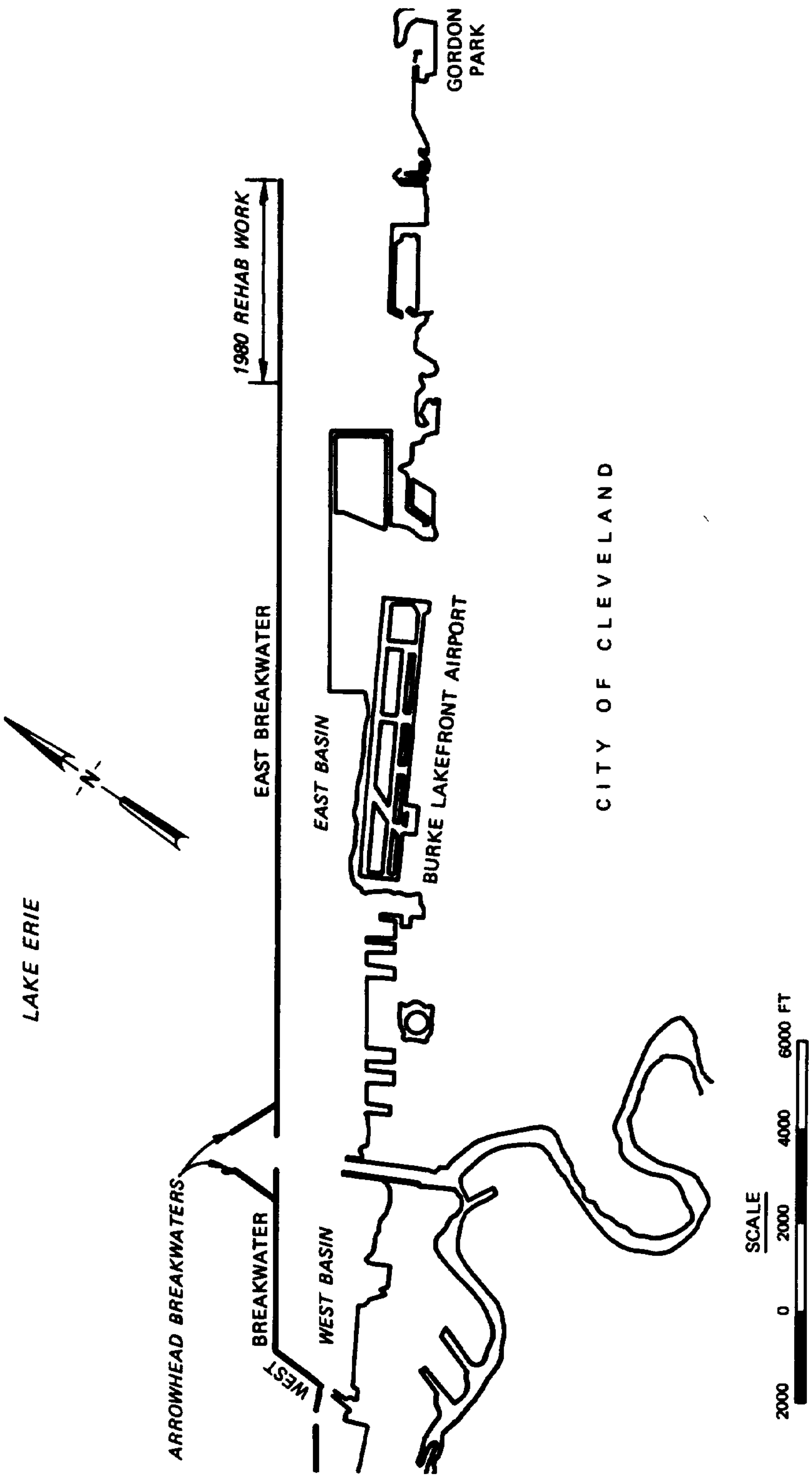

Figure 3-4. Use of arrowhead breakwaters at navigation opening

3-3. Selection of Structure Types. The type of structure selected should be the one that is the most economical, considering both the initial and annual maintenance costs. Also, it should be the one that is the most suitable under the conditions of exposure, depth of water, and nature of the foundation. Breakwaters may be classified as rubble-mound, vertical or wall type, floating, and other.

a. Rubble-mound Breakwaters. Rubble-mound breakwaters are adaptable to a wide range of water depths, suitable on nearly all foundations, readily repaired, and produce less reflected wave action than the wall type. However, they require larger amounts of material than most other types.

b. Wall-type Breakwaters. The wall type includes all structures in which the exposed faces are vertical or slightly inclined. Sheet-pile walls and sheet-pile cells of various shapes are in common use. Reflection of energy and scour at the toe of the structure are important considerations for all vertical structures. If forces permit and the foundation is suitable, steel-sheet pile structures may be used in depths up to about 40 feet. When foundation conditions are suitable, steel sheet piles may be used to form a cellular, gravity-type structure without penetration of the piles into the bottom material.

c. Floating Breakwaters. Floating breakwaters have potential application for boat basin protection, boat ramp protection, and shoreline erosion control. Conditions that favor floating breakwaters are as follows:

(1) Short-period waves. Dependent upon the type of floating structures, the maximum wave period for which the structures are effective ranges from 4 to 6 seconds. The sloping float breakwater (semi-submerged) provides protection intermediate to that achieved by floating breakwaters and fixed breakwaters, i.e., it may prove to be a desirable alternative for protection against 6- to 10-sec waves.

(2) Deep water. Water depth has little influence on in-place costs or performance.

(3) Fluctuating water levels. Where large tidal fluctuations or fluctuating reservoir pool elevations are encountered, the mooring line systems for floating structures can be adjusted to keep the breakwater in its optimum performance configuration.

(4) Water quality constraints. Interference with natural water circulation is minimal.

(5) Ice problems. If ice formation is anticipated, the structures can be towed to a protected area.

(6) Poor foundations. May be the only practical solution where foundation conditions will not support bottom-connected breakwaters.

(7) Aesthetics. Floating breakwaters have a low profile and present a minimum intrusion on the horizon, particularly for areas with large tidal ranges.